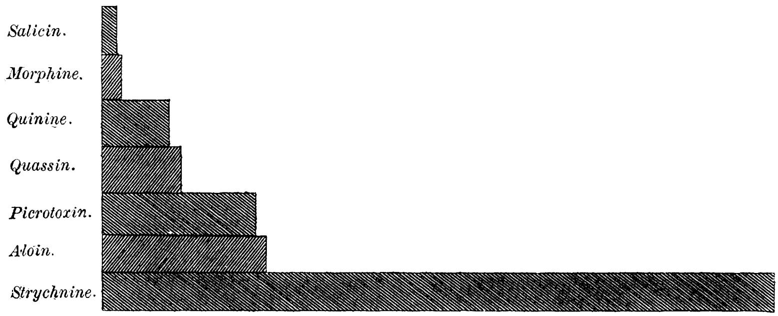
This relative bitterness is best illustrated by the diagram:



AVERAGE OF FORTY OBSERVATIONS.

A comparison of authorities will show that there is a wide difference of opinion as to the amount of some of these substances that can be detected by the sense of taste. Some state that one part of strychnine in 30,000 parts of water can be detected, while others place the figures at one part in 700,000. The above experiments show that the latter is nearer the truth.

Twelve of the experimenters were able to detect one part of strychnine in 1,280,000 parts of water; or if one cubic centimeter be considered as sufficient for a taste, they were able to detect $\frac{1}{170000}$ of a grain. Several who had taken large quantities of quinine were able to detect relatively small quantities of this substance.

The fact that has been previously noticed by chemists, that solutions of aloin lose their strength on standing, was confirmed. The curious anomaly was apparent, that while some could taste solutions of aloin as dilute as those of strychnine, others could not detect any bitterness in a solution which contained one part of aloin in 1,250 parts of water. We were able to detect chemically, by concentration, the strychnine in $\frac{4}{10}$ of a cubic centimeter of a solution that contained less than one part in one million parts of water. So it would seem that a chemical test is about equal to the *average* delicacy of the sense of taste for this substance. In the case of any particular individual, however, the chemical test is liable to be more delicate. It is not necessary to say that the latter is more *reliable*, for it not only detects a bitter substance, but tells what particular principle is present. We have found that sulphuric acid and potassic bichromate gave the most delicate results. It is our intention to continue these experiments, and, by having tests made by a much larger number of persons, to more thoroughly substantiate our results.

ON THE SWEETNESS OF INVERT SUGAR, WITH SOME NOTES ON ITS PREPARATION.

BY J. T. WILLARD, MANHATTAN, KAS.

A solution of cane sugar possesses the power of rotating a ray of polarized light to the right. If this solution be treated for a few minutes with a dilute mineral acid, it is changed so that it becomes levorotary. Hence it is said to be inverted, and the product is called invert sugar. It is produced, though not so rapidly, by the action of organic acids on cane sugar. When fruit is cooked with sugar, much of the sugar is inverted. A determination of the relative sweetness of the two sugars thus assumes a practical aspect.

Invert sugar is usually said to be a mixture of equal equivalents of dextrose and

levulose, although recent work seems to show that the ratio between the two varies somewhat with the conditions of preparation. Levulose is said to be slightly sweeter than cane sugar. Dextrose, according to Parmentier, is five-sixths as sweet as cane sugar. If these estimates be true, we should expect invert sugar to be somewhat less sweet than cane sugar. According to the statement of Tucker, (Manual of Sugar Analysis, page 89,) invert sugar is of rather sweeter taste than cane sugar, and Prof. Henry Morton places the excess at ten per cent. (Ibid, p. 10.)

The determination of the sweetness of invert sugar is beset with many difficulties. As it is an uncrystallizable syrup, it cannot be obtained pure by crystallization from its solution. The methods of preparing it given by authorities, are two, viz.: by inversion of cane sugar by heating with sulphuric acid, and afterward removing the acid by means of barium carbonate, or by heating with hydrochloric acid and removing the acid with silver oxide. Solutions of invert sugar prepared by the former method invariably possess a slightly earthy taste, while those prepared by the second method have a disagreeable, metallic taste, due to solution of a small amount of silver oxide. It was suspected that the earthy taste of solutions prepared by the first method was due to barium carbonate. Upon adding a little clear solution of calcium sulphate a considerable amount of barium sulphate was precipitated, and by filtering again a solution was obtained which, though not absolutely free from foreign taste, was much superior to that prepared by the unmodified method. Another difficulty to be met in preparing this substance is the fact that if the acid be allowed to act too long the sugar is changed still further into humus compounds, and if it is not allowed to act long enough the sugar is not all inverted It was found that 40 g. of sugar in 200 cc. of water were completely inverted in twenty minutes by 3 cc. of concentrated sulphuric acid, without coloring the solution. The temperature was maintained at 75° C. during the whole time. A shorter time may be sufficient, as the minimum period was not determined.

Invert sugar prepared in the manner described was made into solutions of various strength. These solutions were compared with similar solutions of cane sugar. They were submitted to a number of persons, whose opinions as to the relative sweetness of the solutions varied somewhat. Upon the whole, the invert sugar seemed to be about five-sixths as sweet as cane sugar.

Experiments were also made by cooking a definite weight of Winesap apples with sugar, and comparing the product with that obtained by cooking the same amount of apples and sweetening after the cooking was nearly completed. All precautions were taken to make the experiments strictly comparable. These samples were submitted to various persons, and their opinions as to which was the sweeter were evenly divided. This shows conclusively that for all practical purposes fruit may as well be sweetened before cooking as afterward. Analysis showed that in the sample in which the sugar was cooked with the apples, a large proportion of it was inverted. The cooking was purposely continued much longer than necessary, in order to give opportunity for inversion to take place.

In my efforts to prepare invert sugar free from foreign taste acquired during its preparation, attempts were made to invert cane sugar in solution by saturating with carbon dioxide. Lippman states that such solutions are entirely inverted in one hundred and fifty hours; but, although the solutions in my experiments were saturated with the gas and a slow and continuous current was maintained for eleven days, only a trifling amount of inversion took place.